DOCUMENT RESUME

ED 443 668 SE 063 672

AUTHOR Bodzin, Alec M.; Park, John C.
TITLE An Online Inquiry Instructional System for Science Education.
PUB DATE 1999-07-00
NOTE 15p.; In: "Median: A Middle School Computer Technologies Journal," v2 n2, July 1999.
PUB TYPE Reports - Descriptive (141)
EDRS PRICE EDRS Price MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS Computer Simulation; Constructivism (Learning); Educational Technology; Elementary Secondary Education; Inquiry; *Instructional Design; *Instructional Materials; *Science Education; *Systems Approach; *World Wide Web

ABSTRACT

The Carolina Coastal Science Web site is an instructional system defined as an arrangement of resources and procedures used to promote learning. This paper describes the blending of a systems approach to instructional design with additional constructivist elements in order to develop the Carolina Coastal Science Web site. The Web site is an online environment for primary and secondary students of varying abilities which engages them in authentic scientific inquiry. (WRM)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 443 668

An Online Inquiry Instructional System for Science Education

by

Alec M. Bodzin

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY HAS BEEN GRANTED BY

A. Bodzin

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

BEST COPY AVAILABLE

SE 063 072

AN ONLINE INQUIRY INSTRUCTIONAL SYSTEM FOR SCIENCE EDUCATION

Alec M. Bodzin, North Carolina State University

An instructional system may be defined as an arrangement of resources and procedures used to promote learning (Gagne, R., Briggs, L., & Wager, W., 1992). The Dick and Carey (1990) systems approach model for designing instruction is the most well-known systematic instructional design model. Traditional systems approach to instructional design by itself is not compatible with the concept of inquiry-based learning required in an online learning environment. The weakness of the systems approach for instructional design becomes apparent when learning is not linear. Furthermore, the systems approach is being challenged by constructivist theories and models which recognize that social context, roles and relationships are central to learning (Jones, Kirkup, & Kirkwood, 1993). Non-linear development models also recognize that learning is dynamic and unpredictable and that learners can and do make their own decisions about learning tasks (Thorpe, 1995).

Reform movements in science education

New reform efforts taking place in science education today are framed by the tenets of constructivism. Constructivist theorists regard learning as an active process in which a learner constructs knowledge and understanding in an active manner through personal experience or experiential activities. Constructivism has its roots in twentieth century psychology and philosophy and the developmental perspectives of Piaget (1954), Kant (1959), Bruner (1966), and Vygotsky (1978).

Another focus of the current reform movement in science education is to develop students' ability of inquiry as well as understandings of inquiry (NRC, 1996). The national standard on scientific inquiry defines scientific inquiry as "diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work"

SE063072

(NRC, 1996). Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.

Initial ideas for an online inquiry instructional system

In response to the demand of reform efforts and the lack of an appropriate design model approach, the Carolina Coastal Science project commenced with an idea to develop a Web site that was an organized, non-linear information resource in the context of an inquiry-based constructivist learning environment. Most of the content would be original, created specifically for the site,while other material would be available via links to other sites.

One of the main goals of this project was to create an online environment for primary and secondary students of varying abilities to engage in authentic scientific inquiry including: identifying questions that guide scientific investigation, using technology to improve investigations and communications, formulating scientific explanations using logic and evidence, recognizing and analyzing alternative explanations and models, and communicating and defending a scientific argument. This instructional system was created on the World Wide Web due to the fact that the nature of hypertext mark-up language (HTML) supports a user-centered learning environment through a non-linear information landscape. Also, a Web site is not a static entity. It can be a dynamic, changing entity in ways that are simply not possible with traditional printed material. Designing effective materials for science educators that provide instructional strategies based on constructivist approaches and various uses of technology was a challenge of this project.

Another important goal of the design and development process was to create a a user-friendly interface that would make it easy for novice teachers and students to navigate within the web site. Several modes of learning and teaching strategies were chosen to be available to the users, including a role-playing simulation-debate, open-ended inquiries, guided inquiries, independent research, and cooperative group learning.

Carolina Coastal Science

The resulting Web site, Carolina Coastal Science (available online at http://www.ncsu.edu/coast), contains 5 separate areas to engage students in different types of inquiry including:

1. An inquiry simulation in which students investigate the issues concerning the fate of the Shell Island Resort and then debate the future of this and other oceanfront structures threatened by coastal erosion;
2. An interactive photojournal that students can use to construct their own set of inquiry questions to explore;
3. A section of "Inquiry Images" which can be used as whole class guided inquiry activities;
4. A "Coastal Research Technology" section that students can use to identify the scientific instruments used by oceanographers and coastal geologists to collect data;
5. An educator's guide with a variety of teaching suggestions to assist teachers with incorporating the Web site into primary and secondary school classrooms.

The Educator's Guide

The Carolina Coastal Science educator's guide offers science educators a selection of teaching suggestions for implementing the instructional system into a classroom setting. These include:

- Using the "Shell Island Dilemma" as a JIGSAW II small group learning activity. Students work together in expert groups on an information seeking task. The groups are reorganized so that an exchange of ideas and information occurs by peer tutoring.
- Using the "Inquiry Images" as a whole class guided inquiry activity. This web site area can be used to generate discussion and debate on environmental issues.
- Using the "Carolina Coastal Photojournal" and "Coastal Research Technology" sections with students who wish to follow their own learning pathways.

The educator's guide also provides additional suggestions for implementing the instructional system into primary school (Figure 1) and secondary school settings (Figure 2).

Hypertext links occur throughout the educator's guide to facilitate navigation within the web site.

Figure 1: Primary School Suggestions .

- Use the Inquiry Images for entire class discussion.
- Use the Carolina Coastal Photojournal with students to discuss similarities and differences in the amount of sand, visible waves, and plant cover between the ocean side and marsh side of the same barrier island.
- Use the Carolina Coastal Photojournal with students to identify similarities and differences among the three regions of the Carolina Coast. Have the students note the presence and absence of barrier islands, inlets, coastal rivers, and sounds.
- Use the Carolina Coastal Photojournal for students to draw their own barrier island. Have students color in sand and plants.
- Use the quicktime videos and the aerial photographs depicting the migration of Mason's Inlet from October 1989 to November 1995 to enhance the ability of students to make predictions. Students can predict the direction and speed of Mason's Inlet, the fate of the Shell Island Resort and the eventual shape of Figure Eight 8 Island.
- Use the resources from the Coastal Research Technology section to have students brainstorm ideas on what a coastal oceanographer and/or a coastal geologist does. Ask students to think about what kind of tools these scientists might use.

Figure 2: Secondary School Suggestions

- Use the Shell Island Dilemma to engage students in an inquiry simulation debate. Your students' objective is to investigate the issues concerning the fate of the Shell Island Resort and then to debate the future of the Shell Island Resort. As your students engage in the investigation, they will identify the social, political and science issues with which different stakeholders must deal. Students should place themselves into the role of one of the

stakeholders and complete a "Position Statement Handout" during their investigation. A "Student Record Sheet Assessment" is provided for each individual student to complete at the conclusion of the debate.

- Use the Carolina Coastal Photojournal to have students construct their own set of inquiry questions, such as, where should a development occur on the pictured barrier islands; what are the dangers of inlet side development; and, for what reasons should barrier islands be protected from development.

- Use the Shell Island Dilemma in order for students to create a multimedia presentation such as a HyperStudio stack in which they predict the fate of the Shell Island Resort.

- Use the Inquiry Images to generate entire class discussion.

- Use the Carolina Coastal Photojournal for students to predict the best location for an ocean outfall on the Carolina Coast for sewage disposal.

- Use the Internet to locate photographs of other coastal areas in the world and compare these to the Carolina coast. Focus on the presence and absence of barrier islands, coastal rivers and sounds. Where in the world do you find other extensive barrier island systems?

- Explore the Coastal Research Technology section to identify the scientific instruments used by oceanographers and coastal geologists to collect data. Have students use Internet search engines to locate actual coastal data sets acquired with the coastal research equipment.

- Use the ROV video clips with students to identify similarities and differences between natural and artificial reefs in the waters off the coast of Wilmington, North Carolina.

- Use the Cape Hatteras Lighthouse section to develop a debate on the issue of whether or not this lighthouse should be protected. A subsequent debate can conclude with a recommendation on protecting the structure.

- Use other oceanography web sites for students to explore their own coastal research topics.

The Shell Island Dilemma inquiry simulation

The Shell Island Dilemma is an inquiry simulation, in which students investigate the issues concerning the fate of the Shell Island Resort and then debate the future of this and other oceanfront structures threatened by coastal erosion. As students engage in the investigation, they identify the social, political and scientific issues with which different stakeholders must deal. Students place themselves into the role of one of the stakeholders. Questions are used throughout the instructional system to focus student's thoughts during their exploration:

> "As you explore the resources, remember that you are in the role of a stakeholder. Think about the current North Carolina policies regarding the placement of hard structures in public trust areas such as the beach. How does the current coastal policy affect your vested interests as a stakeholder?"

Students are presented with a brief description of their stakeholder role and are then presented with a recommended list of important resources to review. The resources include authentic documents and photographs, including aerial photographs illustrating the recent history of the migration of Mason's Inlet, current photographs of the Shell Island Resort, newspaper articles, statements from coastal engineers, permit applications to construct a hard structure, and meeting proceedings from the North Carolina Coastal Resources Commission. After students review the resources, they are to prepare a statement to decide what should be the next course of action regarding the Shell Island Resort. Students present their statement in a debate to decide the future of the Shell Island Resort. Each student also completes a "Position Statement Handout" (Figure 3).

Figure 3. Position Statement Handout.

1. Is your position for or against building a hard structure to protect the Shell Island Resort?

2. What arguments support your position?

3. What other individuals, interest groups or organizations do you think would agree with your position?

4. What other individuals, interest groups or organizations do you think would disagree with your position?

5. What are some arguments against your position?

6. How would you respond to these arguments?

After students have had enough time to review the resources and prepare their position statements, a class debate is held to decide the next course of action. When the debate is complete, students take a vote on the proposed solutions and conclude the debate when a consensus of 2/3 of the class agrees on a proposed solution. A "Student Record Sheet Assessment" (Figure 4) is completed by each individual student at the conclusion of the debate.

Figure 4. Student Record Sheet Assessment.

1. List all individuals, interest groups, or organizations that were in favor of building a hard structure to protect the Shell Island Resort.

2. List all individuals, interest groups, or organizations that were opposed to building a hard structure to protect the Shell Island Resort.

3. What environmental concerns were identified regarding the issue?

4. What economic concerns were identified regarding the issue?

5. What are the short-term costs and benefits of the proposal?

6. What are the long-term costs and benefits of the proposal?

7. List the 3 strongest arguments in favor of building a hard structure to protect the Shell Island Resort.

8. List the 3 strongest arguments against building a hard structure to protect the Shell Island Resort.

9. How would you personally vote on this issue? Justify your answer.

Applying the Dick and Carey model to the Shell Island Simulation

Although this instructional system was designed to be delivered in a nonlinear environment, each stage of the Dick and Carey model was applied to the design. The Dick and Carey model was then built on with constructivist components. The following explains how each component of the Dick and Carey model was implemented with regard to the instructional design of the Shell Island Simulation:

Determine Instructional Goal

The instructional goal arose out of a need for good environmental science teaching curricular resources that align with North Carolina Department of Public Instruction instructional objectives within the framework of the National Science Education Standards. There is currently a lack of inquiry-based simulations that North Carolina secondary school teachers can use in their classrooms which pertain to real-life problems in the state of North Carolina. The instructional goal of the system is for learners to identify the social, political and moral issues that different stakeholders must deal with in a current environmental science issue - the fate of the Shell Island Resort.

Analyze the Instructional Goal

When students are performing the goal, they investigate the issues concerning the fate of the Shell Island Resort. Students take a position for or against building a hard structure to protect the Shell Island Resort. Students develop a personal view of the issue. Students also identify environmental and economic concerns of various stakeholders regarding the issue.

Analyze Learners and Contexts

Learners use technology skills to explore an online Internet resource of information and use data to construct a reasonable explanation for an unresolved issue. Students must use critical thinking skills to explore an issue which is currently unresolved. Learners take a position in their role-playing which they may not necessarily agree with. Students understand and act on personal and social interests which facilitate development of decision-making skills while experiencing science in a form that engages them in active construction of ideas and explanations. They also communicate investigations and explanations.

Write Performance Objectives

- Students will identify environmental and economic concerns which may result from building a hard structure to protect the Shell Island Resort
- Students will list the 3 strongest arguments in favor of building a hard structure to protect the Shell Island Resort.

• Students will list the 3 strongest arguments against building a hard structure to protect the Shell Island Resort.

• Students will identify all individuals, interest groups, or organizations that are in favor of building a hard structure to protect the Shell Island Resort.

• Students will identify all individuals, interest groups, or organizations that are opposed to building a hard structure to protect the Shell Island Resort.

• Students will prepare a statement to decide what should be the next course of action regarding the Shell Island Resort.

Develop Assessment Instruments

Two different assessment instruments were designed to parallel and measure the learner's ability to perform the listed objectives.

1. After students review the resources, they prepare a statement to decide what should be the next course of action regarding the Shell Island Resort. Students present their statement in a class debate to decide the future of the Shell Island Resort. Each student completes a "Position Statement Handout" which is designed to assess the stated objectives before the class debate occurs.

2. A "Student Record Sheet Assessment" is to be completed by each individual student at the conclusion of the debate.

Develop Instructional Strategy

The strategy used in the instruction to achieve the terminal objectives was to design a role-playing activity. A current unresolved issue is selected - the fate of the Shell Island Resort, which is in danger of being destroyed by the migrating Mason's Inlet. Background information is collected. A real-life scenario is then developed. Stakeholder roles of real people are identified. Student roles are developed. An online research resource is created. A debate format is selected with set time limits . A time limit of two days (assuming 90 minute block periods) is given for student research and a period of 1-2 days is required for the actual debate.

Develop and Select Instruction

The instructional materials are developed in the context of a web site called "The Shell Island Dilemma" which is a section of the Carolina Coastal Science web site. An Educator's Guide is provided which recommends teaching strategies and assessments for implementing the instructional unit. A web site was chosen as the delivery mechanism of instruction because many resources students can explore such as newspaper articles are readily accessible in an online environment.

Design and Conduct Formative Evaluation of Instruction/Revise Instruction

Formative evaluation was conducted in a small group setting with a group of primary and secondary school educators enrolled in a graduate course on instructional design and evaluation of educational materials at North Carolina State University. This group made recommendations to modify the instructional program. These included creating a specific description of each stakeholder within the instructional system and developing a "Student Record Sheet Assessment". The Shell Island Dilemma debate simulation was field tested with a 10th grade environmental

science class. Additional recommendations after the field test resulted in the creation of a "Position Statement Handout" to be used by students during their investigation.

Conduct Summative Evaluation

Summative evaluation was conducted by a marine education specialist, a coastal geologist, a university professor with expertise in curriculum and instruction, and two secondary school environmental science teachers.

Constructivist Elements

The following elements were incorporated into the Dick and Carey model to create a constructivist environment within the instructional system:

• Learning occurs with the context of an authentic learning environment in which students use real information and make decisions in a learning environment.

- Learning occurs within the context of a social experience.
- Learners are provided an experience from multiple perspectives.
- Learners are provided with experience in a knowledge construction process.
- Learners are aware of their knowledge construction process.

Conclusion

The Carolina Coastal Science web site is an instructional system defined as an arrangement of resources and procedures used to promote learning. Although the Dick and Carey systems approach model for designing instruction was designed for linear instruction, this approach can still be used as part of the instructional design and developmental process in an inquiry-based online learning environment. Creating an instructional system in an online environment promotes the use constructivist theories in student learning due to the nature of their engagement within a hypermedia environment. Although the systems approach is currently being challenged by constructivist theories and models which recognize that social context, roles and relationships are central to learning, the Carolina Coastal Science Web site illustrates that the traditional systems model continues to provide a base for the design and development of instructional systems in an online constructivist environment for science education.

References

Bruner, J.S. (1966). *Toward a theory of instruction*. New York:W.W. Norton.

Dick, W., & Carey, L.M. (1990). *The systematic design of instruction*. Glenview, IL: Harper Collins.

Gagne, R., Briggs, L., and Wager, W. (1992). *Principles of Instructional Design (4th ed.)*. New York: Harcourt, Brace, and Jovanovich.

Jones, A., Kirkup, G., & Kirkwood, A. (1993). *Personal computers for distance education: The study of an educational innovation*. New York: St.Martin's Press.

Kant, I. (1959). *Critique of pure reason*. London: Dent/Everyman.

National Research Council (NRC) (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

Piaget, J. (1954). *The construction of reality in the child*. New York: Basic Books.

Thorpe, M. (1995). The challenge facing course design. In F. Lockwood (Ed.), *Open and distance learning today* (pp. 175-184). New York: Routledge.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA:Harvard University Press.

BEST COPY AVAILABLE